and Australia and New Zealand were formed from the smaller islands now existing in those regions, such as Auckland, Campbell, and Macquarrie Islands? The volcanic region, mostly submarine, which stretches from the antarctic volcanoes Erebus and Terror to New Zealand, may in some respects, be connected with such changes in the level of the land during post-tertiary times.

It is obvious that larger tracts of land than at present exist near the South Pole, must have had a remarkably refrigerating effect upon the climate of Australia, especially if by such rising the warm equatorial currents which now surround us on all sides, and even extend their favourable influence as far south as Macquarrie Island in 50° latitude, were driven back by polar currents. If these cold currents reached the southern shores of Australia, surrounding, perhaps, New Zealand, as the South Australian current does at the present day, and which, without doubt, is the cause of the fine climate of the latter; it is easy to account for any physical changes in both countries.

I have been led to forward to you these few, and I fear somewhat desultory observations, in order to draw the attention of Australian geologists to the study of the physical and surface geology of the Alps, which would, I have no doubt, reveal important facts, and assist us in connecting the glacial epoch with New Zealand, and in unravelling some of the causes by which such a remarkable extension of its glaciers has been effected.

Art. XXII.—Part I.—*The Mineral Waters of Victoria.*

By J. Cosmo Newbery, B. Sc., Analyst to the Geological Survey of Victoria.

The analysis of mineral waters is a subject of so much interest to those engaged in scientific and economic pursuits, that I propose to bring before you, from time to time, the results of my investigations in the mineral waters of Victoria. Before speaking of the subject of the present paper, the analysis of waters from a spring at Ballan, and from some of the mines of the Maldon district, it may be as well to make a few general remarks upon the chemical action of water on the crust of the earth. A certain proportion of

all the water that falls on the surface of the earth passes into the soil and from thence through joints and fissures, or by percolation through porous rocks, downwards and becomes subterranean. This water is always more or less charged with carbonic acid, and in passing through rocks which are composed of silicates, it decomposes them, forming carbonates of the alkalies, and alkaline earths. If the carbonic acid is in excess, the whole of these will be carried away as bi-carbonates or simply held in solution by it, for Fresenius has shown that the carbonates of lime and magnesia are soluble in water containing much less carbonic acid than would be required to convert them into bicarbonates. But if there is not sufficient carbonic acid to carry off these substances they would remain in the rock as carbonates, thus increasing its volume and, as Bischof states, in some cases it must give rise to a mechanical force of expansion capable of uplifting the incumbent crust of the earth, or acting laterally, compress, dislocate, and tilt the strata on each side of the mass in which the new chemical changes are developed.

Instances of the first kind spoken of, in which carbonated waters have decomposed granite and carried away everything except quartz and silicate of alumina (kaolin), may be seen in many places in Victoria, as at Bulla Bulla, Dunolly, and Kyneton. The street-cutting at Flagstaff-hill shows a good section of more or less pure silicate of alumina; the original rock undoubtedly belonged to the older basaltic formation, and was at some period, for the most part, hard, dense basalt.

An instance of the second kind may be seen in the greenstone of Mount Camel, a few miles north of Heathcote, which contains carbonate of lime as calcite: this mineral has probably been derived from the rock itself, a specimen of the rock procured by Mr. Norman Taylor, of the Geological Survey, contains calcite in veins and firmly imbedded between the crystals of pyroxine and feldspar, of which the rock is composed. Mr. Taylor states that the rock in place has all the appearance of a stratified rock, but upon examining the specimens, I find these lines which resemble stratification to be lines of decomposition, leading to masses of calcite.

The country near Mount Camel has not been subjected to a detailed geological survey, which would be required to detect the result of the expansive force which must have followed the chemical change in the rock.

Subterranean waters often contain other chemical substances instead of carbonic acid, which would act energetically upon rocks consisting of silicates and carbonates, such as chlorine, fluorine, sulphuric and hydrochloric acids, salts, which, acting upon compounds, produce double decompositions. Even water alone, when at a high temperature, as in the thermal springs, has the power of holding many substances usually considered insoluble in solution. The thermal springs of New Zealand, Iceland, North America, and many other places, hold large quantities of one of the most insoluble substances, silica, in solution. Hot water has also no doubt caused great alterations in the crust of the earth, aiding in the formation of mineral veins, crystalline and metamorphic rocks.

The palæozoic and other rocks of Victoria contain a great number of mineral springs, very few of which have attracted much attention, most of them being known only as brackish water. We may divide them into the six classes, proposed by Dr. Sterry Hunt, for the Canadian waters. The first class to contain alkaline chlorides, with chlorides of the alkaline earths, carbonates being present only in very small quantities, or wholly absent. In this class we may place the waters from some of the salt lakes, the mines at Maldon, and probably that from the salt springs on the Saltwater River, a few miles north of Braybrook.

The second class differs from the first by containing large quantities of earthy carbonates and sulphates, as the waters found in marshy parts of the miocene tertiary in Spring Creek, near Barwon Heads, and those from the quartz mines from Moyston.

The third class contains those waters which, in addition to the above, contain carbonate of soda. In this class we may place some of the Hepburn springs, and perhaps those of Daylesford.

The fourth class consists of those which contain carbonate of soda in excess, as those of Ballan and Glenlyon.

The fifth class are those which contain strong acids, especially sulphuric. I know of no member of this class in the colony.

To the sixth class belong those which contain sulphates in excess. Many waters belonging to this class are found in the Murray basin, and in many of the tertiary strata connected with deposits of selenite. At Mount Tarrengower there are some waters, the solid matter of which consists almost wholly of sulphate of magnesia.

No thermal spring has yet been discovered.

The Ballan spring is one of considerable interest, it belongs, as I have stated, to the fourth class, and contains 117·4 grains of solid matter per gallon, or 1·677 parts in 1000. It is clear, sparkling, inodorous, with a pungent, and slightly alkaline taste.

An analysis shows the 117·4 grains of solid matter to consist of :—

		In 10·0 parts.
Carbonate of Soda - -	68·8	0·983
Carbonate of Lime - -	19·2	0·274
Carbonate of Magnesia - -	22·4	0·320
Carbonate of Iron - -	1·6	0·023
Chloride of Sodium + trace KCl -	5·4	0·077
Sulphuric Acid, Bromine - -	traces	...
	117·4	1·677

It also contains a large volume of carbonic acid in solution, but from the imperfect manner of collection, no two of the bottles which I received contained the same amount. An average determination gave 187 cubic inches of carbonic acid in 100 cubic inches of water, or 519 cubic inches to the gallon, deducting 103 cubic inches, which is the amount that would be required to convert the carbonates into bicarbonates, we have 416 cubic inches per gallon remaining that may be considered free. It is probable that the water may be collected containing much more gas than this, as it was effervescing rapidly when bottled.

The spring rises in a basin-shaped cavity at the foot of a low silurian range, near the township of Ballan, the rocks of this range are slates and sandstones, containing but to a very limited extent any of the ingredients of the water. It attracted the attention of those living in the district many year ago by its effervescence and agreeable taste, and was reported on by Mr. Daintree, late of the Geological Survey, but no attempt was made to bring it into general notice until the present year, when an enterprising Melbourne firm leased from the Government the land in which it occurs. They intend to bottle it and offer it for sale as a seltzer or rather a seidlitz water. What peculiar medicinal properties it may possess I do not know beyond its being a very mild aperient.

The medicinal properties of mineral waters have been

ascribed to various causes. It has been stated that they are due not so much to the common ingredients, like carbonate of soda, as to traces of salts of rare metals, or to a peculiar arrangement of their particles. It was stated by Scouteten, in a paper read before the Academy of Sciences at Paris in July, 1865, that the medicinal value of mineral waters is due mainly to their electrical condition. But this is a question we must leave in the hands of the medical men, and they must decide whether the Ballan water has properties other than those given to it by the substances detected in analysis. At all events it is a most pleasant beverage in warm weather. There are one or two other springs in the neighbourhood of this one, but though the composition of the inorganic matter they contain seems to be the same as that from the spring just described, the amount per gallon is much less. One of them rises through a mass of limestone which has probably been formed by the deposition of the carbonates of the alkaline earths from the water, as the carbonic acid which holds them in solution is given off when the water comes in contact with the air. Indeed, it is probable that to springs of this kind we owe most of the non-fossiliferous beds of limestone, such as are found at Geelong, the Duck Ponds and at Limestone Creek.

The other analyses I wish to call your attention to, are those of the water from some of the quartz gold mines at Maldon. The waters were collected and forwarded to me by Mr. Henry Y. L. Brown, of the Geological Survey. They are very interesting, as the inorganic matter they contain is richer in chloride of potassium than any I can find on record. The following analyses show the composition of waters from the Eaglehawk, Beehive, and Bell's Reef mines.

EAGLEHAWK.

	In a gallon.	In 1000 parts.
Chloride of Potassium	83·428	1·1918
Chloride of Sodium	37·485	0·5355
Chloride of Magnesium	3·657	0·0523
Carbonate of Magnesia	9·600	0·1371
Carbonate of Iron + Al_2O_3 and PO_5	4·572	0·0653
Carbonate of Lime, Sulphuric Acid	traces	...
	138·742	1·9820

BEE-HIVE.

	Contents of one gallon.	Composition per 1000 parts.
Chloride of Potassium	93·502	1·3357
Chloride of Sodium	11·634	0·1662
Sulphate of Soda	19·617	0·2802
Carbonate of Magnesia	11·125	0·1589
Carbonate of Iron + $Al_2 O_3$ and PO_5	1·275	0·0182
Carbonate of Lime	trace	...
Silica	2·208	0·0316
	139·361	1·9908

BELL'S REEFS.

	Contents of one gallon.	Composition per 1000 parts.
Chloride of Potassium	15·409	0·2202
Chloride of Sodium	9·893	0·1413
Sulphate of Soda	10·593	0·1513
Chloride of Magnesium	1·926	0·0275
Sulphate of Magnesia	3·677	0·0525
Phosphates, etc.	0·876	0·0125
Silica	3·766	0·0537
	46·140	0·6590

All these waters contained carbonic acid in solution. Corresponding results were obtained in qualitative analyses of waters from the Derby and Nuggety mines of the same district. The rocks bounding the quartz reefs are lower silurian, and they to a great extent are surrounded by granite. An immense quantity of this has been, and is being decomposed by the action of water, leaving deposits of irregular quartz grains and kaolin. Analyses are about to be made of the feldspars of the granite, as they are the probable source of the potash salt. I was much surprised at not finding a large quantity of sulphate of magnesia in the water, as it occurs as epsomite filling the fissures in the rocks of many of the mines of that district.